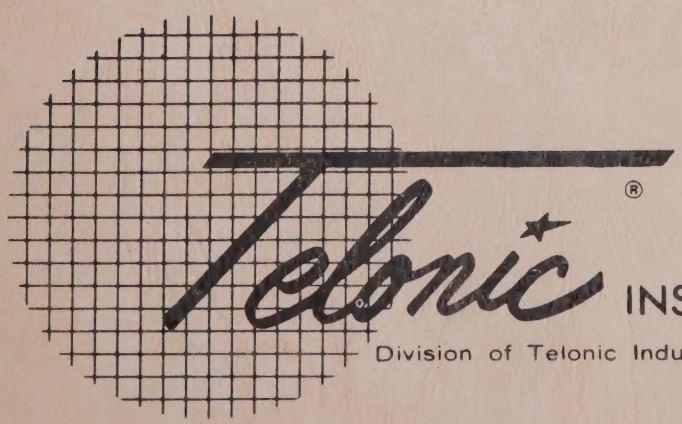
L. CASH.
RACAL
B.C.C.

T.G.LAB
~~G. QUIRK~~.

OPERATION
AND
SERVICE MANUAL



ODEL LA-1M
T.O.S. NO. 135
SERIAL NO. A 23545
PLUG-IN OSCILLATOR

WARRANTY

TELONIC INSTRUMENTS AND ACCESSORIES

Products manufactured by TELONIC INSTRUMENTS; Division of Telonic Industries, Inc. are guaranteed against defective materials and workmanship for a period of one year (vacuum tubes and semi-conductor devices excepted) from date of purchase. This warranty does not apply to instruments that have been altered, improperly handled or damaged in any way beyond our control.

Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time, and to furnish merchandise in accordance with current specifications, without incurring any liability to modify equipment previously sold.

RETURNING EQUIPMENT TO FACTORY

Factory service is available for repair and readjustment of this instrument. However, a description of the trouble, plus the MODEL AND SERIAL NUMBERS of the unit should be forwarded FIRST, whereupon instructions for correcting the trouble OR authorization for returning the equipment will be given. This applies to all units, whether under warranty or not.

MODEL LA-1M
T.O.S. NO. 135
SERIAL NO. A28545
PLUG-IN OSCILLATOR

CONVERSION INFORMATION

Commencing with equipment shipped after about July 22, 1963, certain modifications have been incorporated in the Telonic SM-2000 plug-in series, and in the Telonic SM-2000 control chassis. These modifications may render the units incompatible with those previously shipped unless the earlier instruments are modified also. The equipment in which these modifications have been made can be identified by the letter "A" prefixed to the serial number.

Units not so identified must be modified if they are to be compatible with instruments now being shipped. The modifications to be made are listed below, divided into two groups - those to be made to earlier SM-2000's and those to be made to earlier plug-ins.

SM-2000 CHANGES

1. On J601, remove all wires presently connected to pin 8 and reconnect them at pin 7; remove the jumper between pins 7 and 8.

2. Using shielded wire, type RG-174/U or equal, connect pin 8 of J601 to the printed circuit board land which leads to pin 1, V303. Ground the shield by connecting it to a convenient ground land nearby.

3. Prefix the letter "A" to the serial number of the instrument.

PLUG-IN CHANGES

1. On P601 remove all wires presently connected to Pin 8 and reconnect them at pin 7; remove the jumper between pins 7 and 8 if one is connected.

2. Prefix the letter "A" to the serial number of the instrument, if none is prefixed.

Changing the serial number of the instrument is as important in the modification as are the electrical requirements, as the ability to identify a unit as having been or not having been modified is involved.

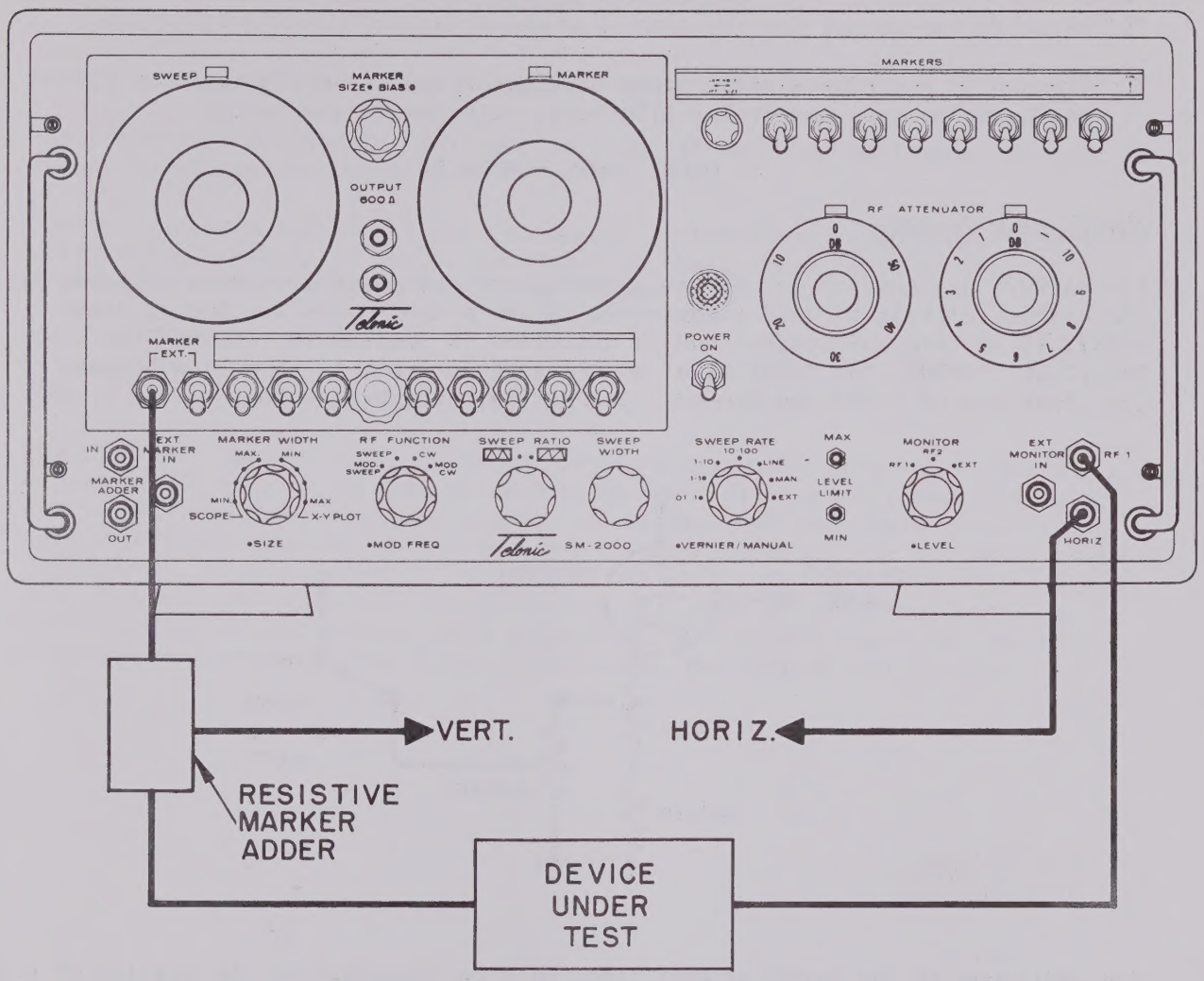
SECTION I .. SPECIFICATIONS

INTRODUCTION TO THE LA-1M

The LA-1M is a plug-in oscillator unit for use with the designated Telonic Control Chassis. It covers the audio frequency range with a heterodyne output. Sweeping is accomplished by varying the current through the control winding of a saturable reactor. The LA-1M is equipped to utilize the variable sweep rate and choice of trace/retrace time available on the control chassis.

SPECIFICATIONS

FREQUENCY RANGE	20 cps - 20 kc
SWEEP WIDTH	50 cps - 20 kc
OUTPUT POWER	0.5 watts
FLATNESS	± 2.5%
OUTPUT VOLTAGE	
Into 50Ω	5 vrms
Into 600Ω	18 vrms
OUTPUT IMPEDANCES	50Ω 600Ω
PULSE MARKERS	
Fixed	
Amplitude	0-60 v
Frequencies	As specified in 20 cps - 20 kc range
Accuracy (Crystal-Controlled)	± 25 cps
Variable	
Amplitude	0-50 v
Frequency	20 cps - 20 kc
Dial Accuracy	± 200 cps
Marker Width	30 cps



GENERAL

1. Make sure the power is OFF. Plugging in the LA-1M with power ON results in transient voltages which can damage diodes.

2. Disconnect the cable connecting the monitor block to the RF Attenuator chassis.

3. Connect the output of the LA-1M to the RF Attenuator on the control chassis.

4. Plug in the LA-1M.

5. Make connections to the scope (or recorder) and device under test as shown above. If internal markers are to be used, the cable connected to the EXT MARKER output jack of the LA-1M may be omitted.

6. Set the MONITOR Switch on the control chassis in the RF-2 position.

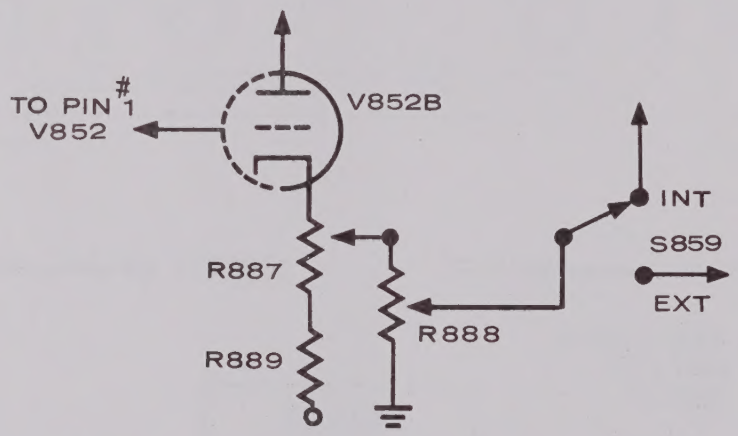
7. Refer to the manual for the control chassis for additional instructions.

8. Proceed in accordance with recommendations from the manufacturer of the device under test concerning alignment, adjustment, and tests.

FRONT PANEL CONTROLS

MARKER SIZE (R-888)

The markers are coupled out of the marker circuit through a cathode follower stage. The cathode circuit of this stage contains two potentiometers. One of these, R-887, is an internal control and is discussed in Section IV, CALIBRATION PROCEDURE. R-888, the front panel MARKER SIZE Control, is connected between the wiper arm of R-887 and ground. See partial schematic below.



The amplitude of the marker output then, will be dependent on the setting of R-888, and can be varied between zero and the amplitude available at the wiper arm of R-887.

MARKER BIAS (R-883)

R-883 is connected in a voltage divider between B+ and ground. The DC voltage at the wiper arm furnishes the bias for the diodes in the marker circuit, keeping them in a non-conducting state until the signal level is sufficiently high to override the bias. Proper setting prevents formation of spurious markers. Both the shape and amplitude of the markers also are affected by this control, and maximum setting (minimum bias) will overdrive the marker amplifier, causing higher intensity at the top of the marker. This may be desirable on fast or wide sweeps for clearer marker viewing.

CHASSIS CONTROLS

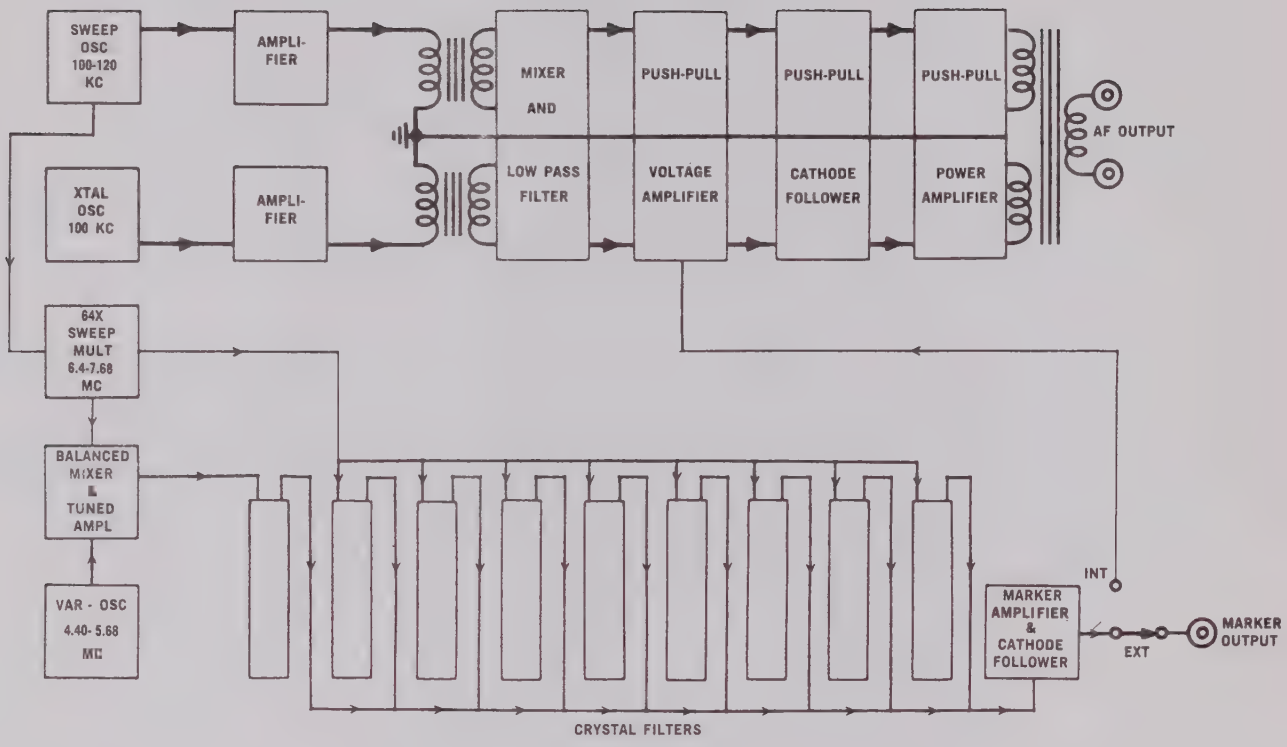
MARKER BIAS LIMIT (individual controls) (R-864-872)

These controls are set for maximum (or less, if desired) amplitude without formation of spurious markers.

Spurious markers are more likely to appear at low sweep rates and/or low sweep widths; hence, it may be desirable to reset these controls for applications involving slow or narrow sweeps.

BAL	UNBAL 50Ω	
600Ω	600Ω	(switch)

This switch, together with choice of output connectors, sets the output impedance of the LA-1M by changing the tap points on the output transformer secondary. In the BAL position, the banana jacks on the front of the LA-1M present an output of 600Ω balanced to ground. There is no output at the 50Ω BNC jack on the control chassis in this position. With this switch in the UNBAL position, outputs with 50Ω and 600Ω internal impedances are available at the front panel (RF 1) connector and at the banana jacks respectively. In this position, the RF attenuators must be in the 0 db position when the 600Ω output is used.



BLOCK DIAGRAM

SECTION III .. GENERAL DESCRIPTION

GENERAL

This is a general discussion of the LA-1M and its theory of operation. The individual component circuits of the LA-1M are discussed in greater detail in the following sub-sections. The unit consists of the following components:

100 to 120 kc sweep oscillator

100 kc crystal-controlled oscillator

Mixer, filter, and amplifier for converting these two oscillator outputs to a 5 vrms, 20 cps to 20 kc, sweep or CW output

Variable marker circuit which is standard on the LA-1M

Circuitry for 8 crystal-controlled fixed markers (crystals optional)

AF OUTPUT

The 100-120 kc sweep oscillator is a modified Colpitts circuit swept by a saturable reactor. The 100 kc oscillator is also a Colpitts type circuit operating at a crystal-controlled frequency but adjustable over a narrow range. The outputs of these oscillators are heterodyned in a balanced mixer circuit and the audio difference frequency coupled to an amplifier circuit through a low-pass filter circuit.

MARKERS

Markers are produced by the action of a sweep sample, frequency multiplied to the 64th harmonic, in the variable and fixed marker circuits. A variable oscillator operating over a range 2 Mc below that of the 64th harmonic of the sweep oscillator furnishes the CW signal for the variable marker. Both the variable marker and all fixed markers are produced by detecting the envelope of a crystal filter response This envelope is clipped and amplified for sharpness.

OSCILLATOR-AMPLIFIER SECTION

SWEEP OSCILLATOR

This oscillator operates in the 100-120 kc range. Center frequency is tunable at the SWEEP Dial on the front panel by varying centering current in the saturable reactor control winding. This center frequency is swept by varying the current through the control winding at a rate determined by the variable rate circuit on the control chassis. The inductance of the signal winding, in the oscillator tank circuit, is determined by the control winding current. The sweep drive is a function of the control chassis and is adjusted by controls located on both the control chassis and the LA-1M.

This oscillator is used for two purposes:

1. Its output is heterodyned in a balanced mixer circuit with a 100 kc crystal-controlled signal.
2. It furnishes a signal which is frequency-multiplied to the 64th harmonic to produce markers.

CRYSTAL OSCILLATOR

This fixed-frequency oscillator developes the 100 kc signal which is heterodyned with the signal from the sweep oscillator.

The oscillator is a modified Colpitts circuit. The crystal is series resonant at 100 kc and constitutes a low impedance feedback path at that frequency.

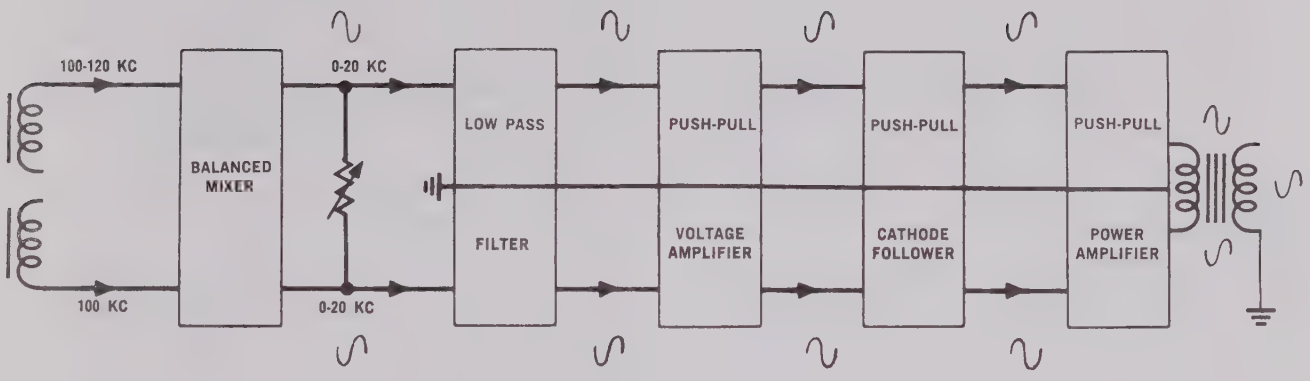
BUFFER AMPLIFIERS

These stages perform two functions--amplification and buffer action.

The outputs of the sweep oscillator and the 100 kc oscillator are each amplified and coupled through separate cathode follower circuits and isolation transformers to a balanced mixer.

AUDIO-FREQUENCY SECTION

The audio-frequency section of the LA-1M functions is shown in the partial block diagram on the following page.



DOUBLER CHAIN

A swept signal from the sweep oscillator is introduced in phase opposition at the grids of the two tubes of a frequency doubler stage. The output of this stage is similarly fed to another frequency doubler stage, and so on through a total of six stages of frequency doubling. This action produces a signal at the 64th harmonic of the 100-120 kc sweep oscillator output. This harmonic produces a sharp, narrow marker. Over-coupling and damping broaden the response sufficiently to accommodate the frequency range of the sweep oscillator.

MARKER CIRCUIT

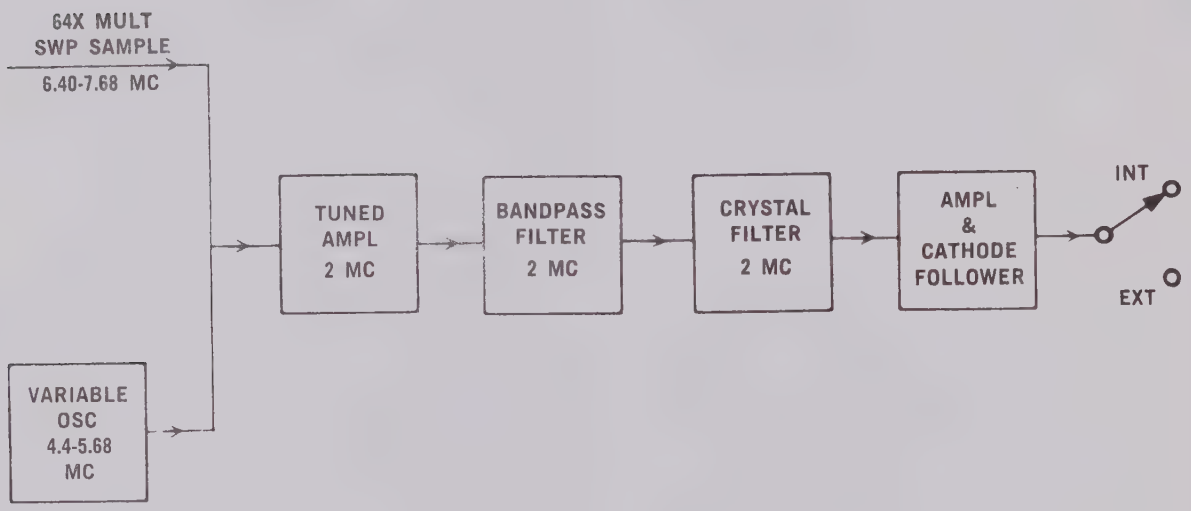
VARIABLE MARKER

The variable marker is produced by the beat frequency of the 64th harmonic of the sweep frequency and the output of an oscillator with an output frequency variable from approximately 4.4 to 5.68 Mc.

The variable oscillator is a parallel-fed modified Colpitts circuit with capacitive coupling in the plate-to-grid feedback path. Mixing with the multiplied sweep frequency is accomplished in the grid circuit of an amplifier which is plate-tuned to 2 Mc. The output of the tuned amplifier is filtered by a band pass filter tuned to 2 Mc. One section of the filter contains a 2 Mc crystal to provide sharp cutoff and an accurate marker.

A typical variable marker is derived as follows:

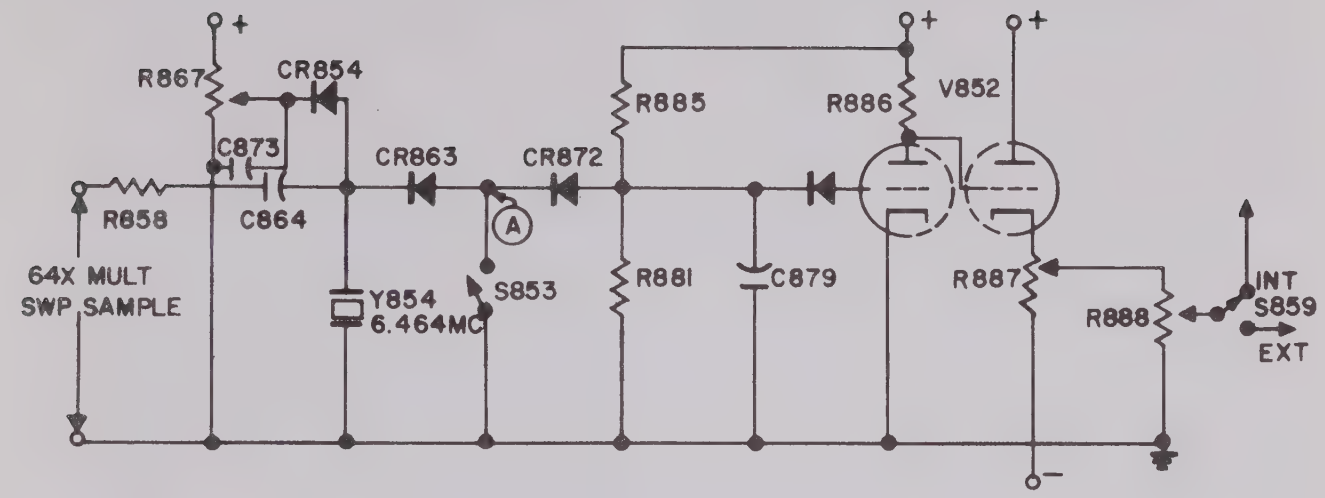
Consider the case when the variable marker oscillator dial is set for 10 kc. This sets the marker oscillator frequency at 5.04 Mc. The sweep oscillator sweeps across the 110 kc point; the 64th harmonic of the sweep frequency is at 7.04 Mc. This will produce a beat frequency difference of 2 Mc, the frequency to which the mixer-amplifier is tuned. This will be passed by the filter to the marker amplifier and produce a marker. At that instant the AF output is 110 kc minus 100 kc (difference between sweep and crystal oscillator outputs) or 10 kc, the reading on the MARKER Dial.



FIXED MARKERS

Fixed markers are produced by the action of crystal band pass filters on the 64th harmonic of the sweep oscillator output. These crystals pass only the frequency to which they are resonant to the marker amplifier. The crystals are parallel resonant at the 64th harmonic of selected frequencies in the 100-120 kc range.

The 64X multiplied sweep signal is coupled to the grid of the marker amplifier through each marker sub-circuit as shown on the following page for a 1.0 kc marker.



Until such time as the signal level is sufficient to overcome the positive bias on the diodes, the marker amplifier is in a steady conduction state, since the amplifier grid is clamped near zero. At frequencies other than a narrow band near 6.464 Mc, the crystal and holder capacitance is a low impedance path and shunts the signal to ground. At a multiplied sweep oscillator output near 6.46Mc, the parallel resonance of the crystal exhibits a high impedance, and the signal at Point A is high enough to override the diode bias. Diode conduction then produces a marker signal at the grid of the marker amplifier.

In the example shown, the crystal frequency is the 64th harmonic of 101 kc. When the sweep oscillator is operating at this frequency, the audio output is 1 kc (101 kc from the sweep oscillator minus 100 kc from the crystal oscillator.) Thus a 1 kc marker is produced. The marker sharpness due to using the 64th harmonic of the sweep frequency is further enhanced by the sharp impedance curve of the crystal filter.

The markers are disabled by individual switches which, when closed, ground the detected output of the crystal filter at a point which does not interfere with the development of the other markers.

OUTPUT STAGES

The pulses are amplified, inverted, and coupled to a cathode follower stage. The coupling from the cathode follower stage to the pulse output stage includes adjustments for setting the base of the pulse at 0v d.c. and for controlling pulse amplitude.

MARKER (Int/Ext Switch) (S-859)

S-859 is a single-pole double-throw switch which routes the markers to J-851 (EXT position) or (INT position) to the cathodes of the push-pull voltage amplifier for pulse modulation of the AF output.

SWEEP (Frequency Dial) (R-608)

R-604, in the grid circuit of the reactor drive pass tube on the control chassis, determines the centering current through the saturable reactor control winding and thus the inductance of the signal winding. This dial sets the center resonant frequency within the limits set by the HI and LO controls (R-606 and R-609) as described in Section IV, CALIBRATION PROCEDURE.

Since the LA-1M is capable of sweeping the full frequency range (20 cps - 20 kc) at any frequency, this control has no noticeable effect at full sweep width.

EXT MARKER (Output) (J-851)

When S-859 is in the EXT position, all fixed and variable markers generated by the LA-1M are routed to this connector and applied to the scope through a separate cable connection.

MARKER (Dial) (Varies C-851)

This control varies the capacitance of the tank circuit of V-851A, the variable oscillator which furnishes the CW signal for the variable marker. It causes the variable marker to appear at the point corresponding to the frequency indicated on the MARKER Dial.

FIXED MARKER (Switches) (S-851 through S-858)

Each of these switches, when open, connects an individual crystal band pass filter, marker mixer, and size control to the grid of the marker amplifier. This causes a marker to appear at a point corresponding to the frequency indicated on the tag above the switch. When these switches are closed, the filter outputs are grounded.

OUTPUT (600Ω)

The LA-1M output impedance at these banana jacks is 600Ω.

With S701 in the UNBAL position, the jack on the right (front view) is grounded. With S701 in the BAL position, the center tap of the transformer secondary is grounded, and both these jacks are above ground.

SECTION IV

CALIBRATION PROCEDURE

Complete calibration of the LA-1M involves adjustment of three different classes of controls:

Those located in the LA-1M which affect the operation of the control chassis.

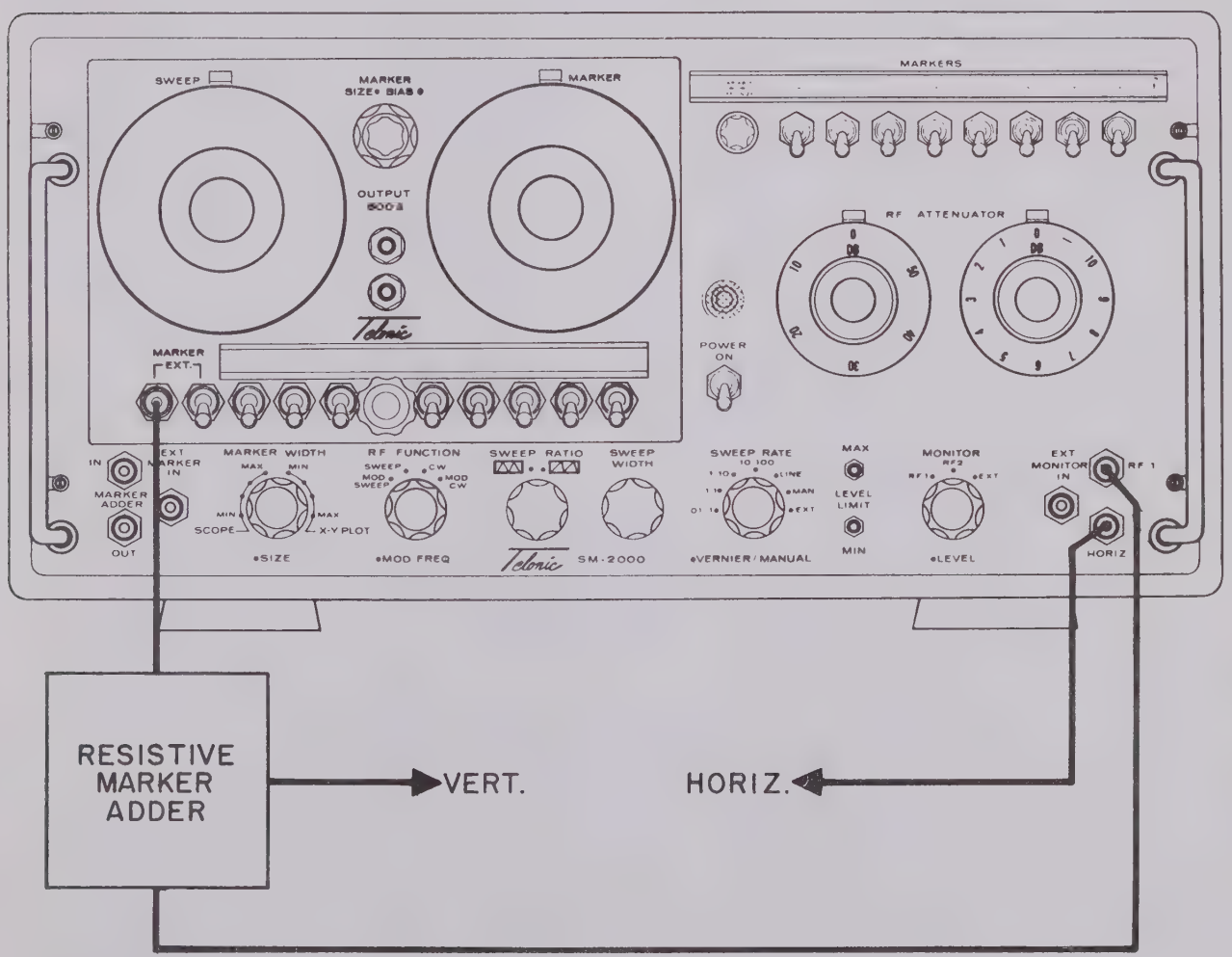
Those located in the LA-1M affecting LA-1M functions only.

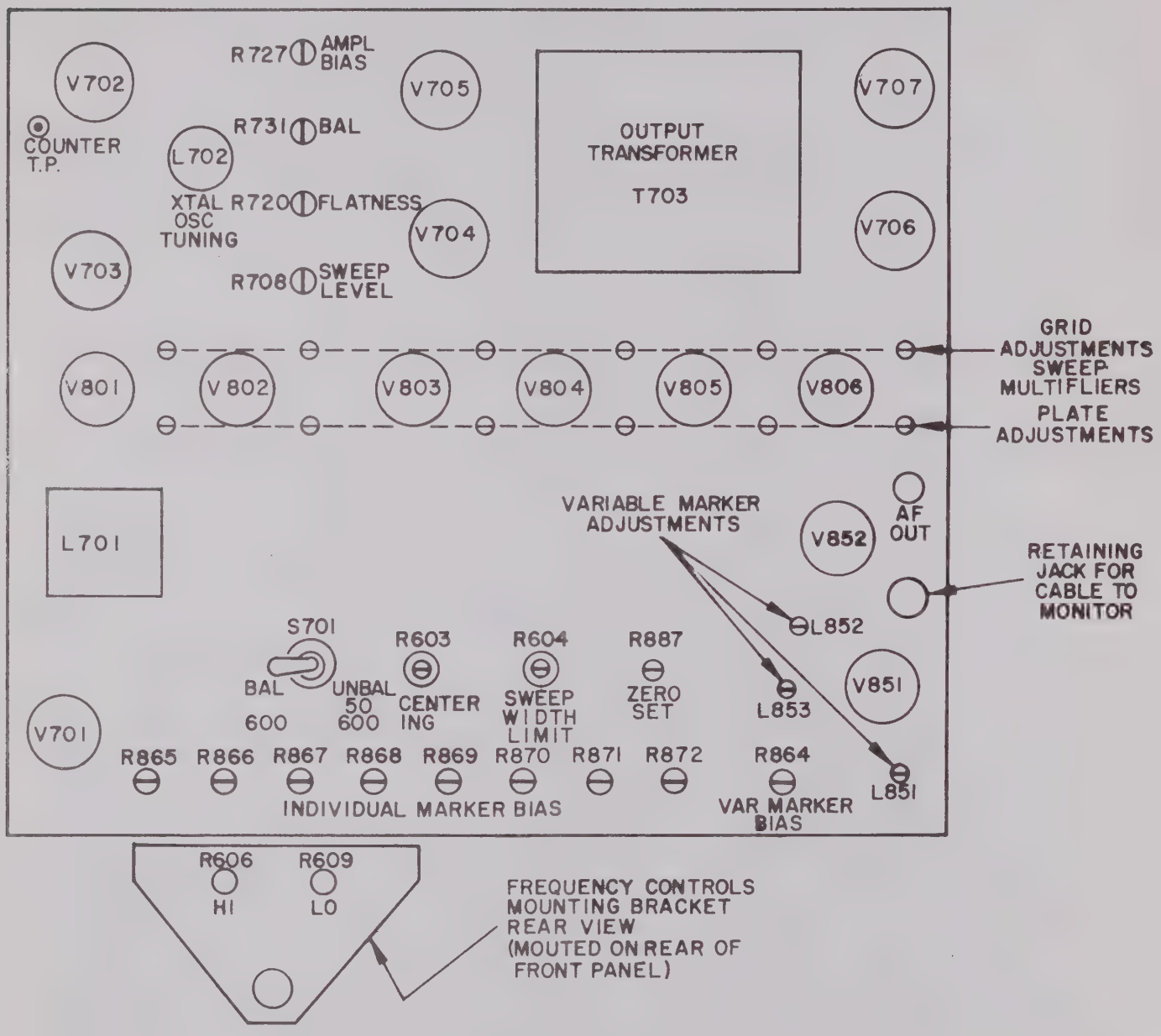
Those located in the control chassis which affect the operation of the LA-1M.

The latter class of controls is discussed in the manual for the control chassis. The adjustment of all controls located in the LA-1M is treated here.

Test equipment required:

Oscilloscope
Counter or other frequency monitoring device
VTVM or 20,000Ω per volt VOM
High-impedance, non-loading diode probe





CHASSIS LAYOUT
TOP VIEW

Follow the setup procedure as outlined in Section II, OPERATING INSTRUCTIONS, omitting the device under test.

MARKER ADJUSTMENT

1. Preset the following controls:

   Oscilloscope
   - Horizontal deflection voltage to external
   - Vertical sensitivity to 200v full scale

   Control Chassis
   - RF ATTENUATOR to 0 db
   - RF FUNCTION Switch to SWEEP
   - SWEEP RATE to 10-100 position
   - SWEEP RATE VERNIER fully counter-clockwise
   - SWEEP WIDTH maximum clockwise
   - SWEEP RATIO to
   - All Markers OFF

   LA-1M
   - All Markers OFF
   - SWEEP (dial) to 10 kc
   - MARKER BIAS fully counter-clockwise (maximum bias)
   - MARKER SIZE fully clockwise
   - ZERO SET for 0v d.c. (this setting gives the same base line on the oscilloscope as is present when the scope is not connected to the LA-1M)
   - All individual MARKER BIAS LIMIT Controls fully counter-clockwise

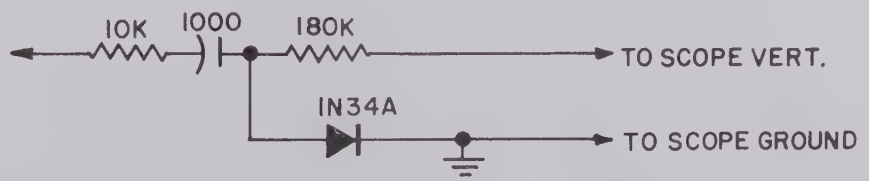
VARIABLE MARKER

NOTE: The tuned circuits in the variable marker line should not ordinarily be adjusted. If adjustment is necessary, a 2 Mc CW source into the variable marker mixer line is required.

1. Turn the variable marker off.

2. Link-couple a 2 Mc CW source to L852.

3. Connect a high impedance, non-loading diode probe to Pin 6, V851 and the probe output to the vertical scope input. A typical probe circuit is shown below:



4. Adjust L852 for maximum amplitude.

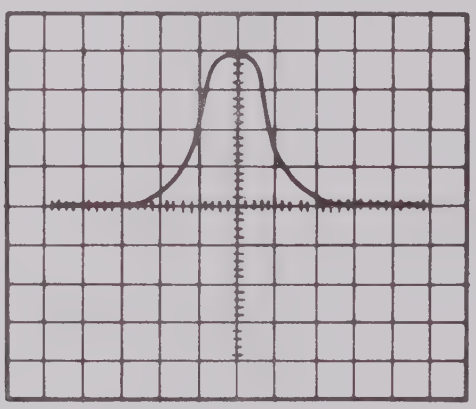
5. Connect the probe to the junction of Y851, C858, CR860, and CR851. Link-couple the 2 Mc signal into L853. Adjust L853 for maximum amplitude.

6. Disconnect the CW source and turn the variable marker ON.

7. Set control chassis SWEEP WIDTH Control fully clockwise.

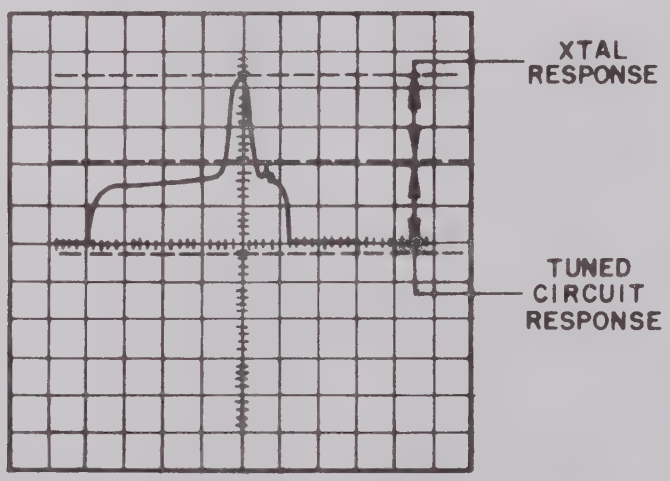
8. Set the LA-1M SWEEP and MARKER Dials for the same reading; the front panel MARKER BIAS Control fully clockwise.

9. Set R864 and the control chassis SWEEP WIDTH Control for a scope pattern showing a response similar to the following.



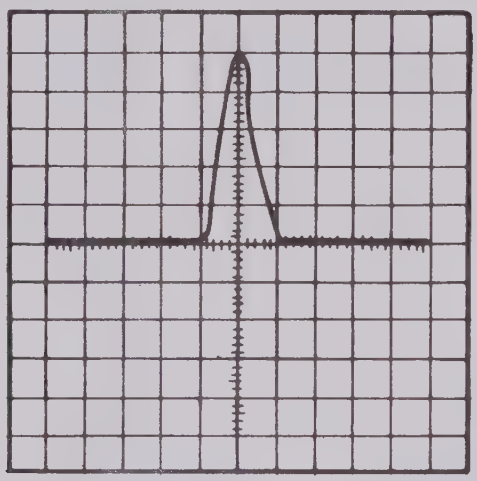
10. Readjust L852 for maximum crystal response (this is the desired marker).

11. Detune L853 to the low frequency side to reduce tuned circuit response until the crystal response clearly dominates the scope pattern.



12. Adjust R864 to leave only the crystal response on the scope.

13. Set the variable MARKER Dial for 1 kc and adjust L851 to superimpose the variable marker over a 1 kc fixed marker.



MARKER BIAS LIMIT (R865-R872)

Adjust these controls for approximately 60v marker amplitude.

SWEEP OSCILLATOR ADJUSTMENT

1. Preset the following controls:

Oscilloscope
Horizontal deflection voltage to external

Control Chassis
All controls same as for MARKER ADJUSTMENT above

LA-1M
All markers OFF
Frequency dial to zero

2. Adjust SWEEP LEVEL Control (R-708) for rated output amplitude (see SPECIFICATIONS).

3. Adjust AMPL BIAS Control (R-727) for minimum distortion. This sets the d.c. voltage at the wiper arm of R-731, the BAL Control.

4. Adjust BAL Control for minimum amplitude variations at the zero frequency point on the sweep. This control balances the outputs of the push-pull cathode followers, V-705.

5. Set the RF FUNCTION Switch on the control chassis to CW.

6. Readjust SWEEP LEVEL Control (R-708) for maximum amplitude with minimum distortion over the entire range (0.02-20 kc) of the LA-1M.

7. Adjust FLATNESS Control (R-720) for minimum distortion. This control sets the amplitude of the sweep signal fed to the balanced mixer to the proper level for optimum heterodyne action with the 100 kc crystal oscillator signal.

100 KC OSCILLATOR

100KC OSCILLATOR ADJUSTMENT (L-702)

A counter test point is provided for convenient adjustment of this control.

L-702 is set for 100.0 kc output at this point.

DOUBLER CHAIN

The tuned circuits in this circuit are preadjusted at the factory and ordinarily require no adjustment. If adjustment is made, turn on all markers and:

1. Follow MARKER ADJUSTMENT Procedure.

2. Adjust each tuned circuit for the maximum marker amplitude obtainable without spurious markers.

CONTROLS AFFECTING CONTROL CHASSIS

The following components, although located in the LA-1M, control certain features located in the control chassis. They are located in the plug-in head because the setting required depends on the plug-in head used. First preset the following controls:

Oscilloscope
- Horizontal deflection voltage to external

Control Chassis
- RF ATTENUATORS to 0 db
- RF FUNCTION Switch to SWEEP
- SWEEP WIDTH fully counter-clockwise
- All Markers OFF

LA-1M
MARKER BIAS (Front Panel) and MARKER SIZE (Front Panel) for optimum markers
10 kc and 20 kc markers ON
Other markers OFF

CENTERING (R-603)

Set the SWEEP Dial of the LA-1M for 10 kc. Adjust R-603 to bring the 10 kc marker on the scope presentation.

LO (R-609)

Set the SWEEP Dial at 0 kc. Adjust R-609 to bring the 0 frequency point on the scope presentation.

HI (R-606)

Set the SWEEP Dial for 20 kc and adjust R-606 to set the 20 kc marker on the scope presentation.

NOTE: It may be necessary to "rock" back and forth between these three controls adjusting first one and then the other until all three are adjusted correctly. The SWEEP Dial is calibrated at the factory at minimum sweep width and this procedure will bring the SWEEP Dial back into calibration at minimum sweep width.

SECTION V .. MAINTENANCE

NOTE: Before assuming an apparent malfunction to be a trouble, be sure that the operating instructions are being followed exactly; for instance, the monitor switch should be in the RF 2 position. If the 600Ω UNBAL output is used, the 50Ω attenuators must be in the 0 db position.

GENERAL

Since the LA-1M is a plug-in unit, many of the possible malfunctions in the head are the result of part failure in the control chassis. The connections at P601 of the LA-1M, and at J601 of the control chassis afford a convenient means of tracing the source of the trouble to the LA-1M or the chassis.

In locating troubles which have been traced to the LA-1M, common sense rules apply. These include obvious visual checks for damage, charred resistors, glowing anodes, and shorted tuning capacitors. All connectors, particularly J601 and P601, should be checked for cleanliness.

TROUBLE SHOOTING

The following chart will be of service in deciding whether a trouble lies in the LA-1M, or control chassis. It is assumed that the above procedures have been applied, that the jumpers on P601 are intact, and that the prescribed calibration procedure has been followed. Where "inconclusive" is shown, the next step should be followed.

TROUBLE SHOOTING CHART

SYMPTOM	CHECK	IF RESULT IS	TROUBLE PROBABLY IN	
			LA-1M	CONTROL CHASSIS
No output (All checks made with S859 in EXT position)	1. Outputs of V701 and V702 with probe.	Output from V701, none from V702, or output from both.	X	
		Output from V702, none from V701.	Inconclusive. See check #2.	
		No output from either V701 or V702.	Inconclusive. See check #2.	
	2. Supply voltages at Pins 3,4,5,12 of J601. With LA-1M removed.	Improper values		X
		Normal	Inconclusive. See check #3.	
	3. Resistance between Pins 5,12,20,28, 29 of P601 and ground with LA-1M removed. Resistance between Pins 14 and 15 of P601 with LA-1M removed.	Open on any check	X	
		Resistance	Inconclusive. See check #4.	
	4. V406 (in control chassis) and associated circuitry.	Defective components		X
		No defective components	X	
Weak Output	1. Resistance, Pin 30 to Pin 4 of P601. With LA-1M removed.	Open	X	
		Resistance	Inconclusive. See check #2.	
	2. V406 and associated circuitry	Defective components		X
		No defective components	Inconclusive. See check #3.	
	3. Supply voltages at Pins 3,4,5, 12 of J601. With LA-1M removed.	Improper values		X
		Normal	X	

SYMPTOM	CHECK	IF RESULT IS	TROUBLE PROBABLY IN	
			LA-1M	CONTROL CHASSIS
No sweep width	1. Voltage waveform across R470.	Normal amplitude sawtooth or triangular waveform	X	
		0v or DC voltage	Inconclusive. See check #2.	
	2. Next - resistance between Pins 14 and 15, 28 and 29, 30 and 4, P601 with LA-1M removed.	Open on any check	X	
		Resistance		X
No variable marker, normal fixed markers	Voltage at Pin 1, P601 with S509 ON.	+100v	X	
		Low or zero		X
No blanking	CR701	Good		X
		Shorted or reversed	X	

If the chart shows that the trouble probably is in the control chassis, refer to the MAINTENANCE Section of the Control Chassis manual.

If the trouble appears to be in the LA-1M, the following chart may be of assistance in localizing the failure.

SYMPTOM	CHECK
No output	Outputs of all stages V701 through V707, using signal tracing methods. When defective stage is located, check tube and associated circuitry.
Weak output	Diodes in balanced mixer circuit. Using signal tracing methods, check outputs of V701-V707 and proceed as above; R601.
No sweep width	The checks listed in the chart will probably indicate the trouble as being R602, R603, R604, or L701A.
No variable marker with normal fixed markers (refer to Section III for further information)	V851A for oscillation. Check CR851, CR860, CR869. Check V851B and associated circuitry.

The following are additional aids in locating troubles which may be in the LA-1M and are not listed above:

SYMPTOM	CHECK
Distorted output	Check CR702-5 for proper matching and push-pull tubes for equal operating level with opposed tube.
Output not flat	R720, C714, C715
Variable markers, no fixed markers	L812
No markers	V852 and associated circuitry; sweep multiplier chain; check R884.
Weak markers	V852; sweep multiplier chain.
Markers absent or weak at one or more fixed frequencies	Associated diodes and crystals; sweep multiplier chain.
Spurious markers	Biasing diodes; R882; R885.
Positive d.c. but no markers at J851	Turn off all markers; if positive voltage is still present, check R864 and C870. If positive voltage disappears, turn markers on and off singly. If only one marker circuit is causing the trouble, check the associated MARKER BIAS LIMIT Control and 0.02 µf capacitor. If the voltage is present regardless of which marker switch is ON, check R882, R883.

SECTION VI

PARTS LIST

CIRCUIT REFERENCE NO.	DESCRIPTION	TELONIC PART NO.
C601	CFC, 470pf, GMV, 1000 VDCW	C-18
C701	CFM, 270pf, ±5%, 500 VDCW	C-25
C702	Same as C701	
C703	CFM, 1200pf, ±5%, 500 VDCW	C-95
C704	Same as C703	
C705	Same as C701	
C706	CFM, 1000pf, ±10%, 500 VDCW	C-51
C707	Same as C706	
C708	CFC, 200pf, ±10%, 1000 VDCW	C-16
C709	Not assigned	
C710	CFM, 470pf, ±5%, 300 VDCW	C-26
C711	Same as C710	
C712	Same as C706	
C713	Same as C708	
C714	CFP, 0.1µf, ±20%, 200 VDCW	C-200
C715	Same as C714	
C716	CFMY, 0.04µf, ±10%, 400 VDCW	C-83
C717	CFC, 0.02µf, +80-20%, 500 VDCW	C-21
C718	CFE, 5µf, 150 VDCW	C-304
C719	Same as C718	
C720	CFE, 30µf, 450 VDCW	C-332
C721	CFC, 72pf, ±10%, 1000 VDCW (SC)	C-12
C801	Same as C706	
C802	CFM, 250pf, ±5%, 500 VDCW	C-108
C803	Not assigned	
C804	CFC, 75pf, 1000 VDCW	C-12
C805	CFC, 33pf, ±10%, 1000 VDCW	C-10
C806	CFM, 2200pf, ±10%, 500 VDCW	C-24
C807	Same as C806	
C808	Same as C710	
C809	CFM, 330pf, ±5%, 500 VDCW	C-97
C810	Same as C701	
C811	Same as C701	
C812	CFC, 50pf, ±10%, 1000 VDCW	C-11
C813	Same as C812	
C814	CFC, 10pf, ±10%, 1000 VDCW	C-6
C815	Same as C814	
C816	Same as C717	
C817	CFC, 5000pf, +80-20%, 500 VDCW	C-49
C818	Same as C817	
C819	Same as C817	
C820	Same as C817	
C821	Same as C817	

CIRCUIT REFERENCE NO.	DESCRIPTION	TELONIC PART NO.
C822	Same as C817	
C823	Same as C717	
C824	Same as C717	
C825	Same as C717	
C826	Same as C717	
C827	Same as C717	
C828	CFC, 7pf, ±10%, 1000 VDCW	C-5
C829	CFC, 15pf, ±10%, 1000 VDCW	C-7
C851	CVA, 36pf max.	C-433
C852	Same as C804	
C853	Same as C706	
C854	Same as C828	
C855	CFC, 1000pf, GMV, 1000 VDCW	C-19
C856	Same as C809	
C857	Not assigned	
C858	Same as C814 (SC)	
C859	CFM, 680pf, ±10%, 500 VDCW	C-98
C860	Same as C859	
C861	Same as C812	
C862	CFC, 4pf, ±10%, 1000 VDCW	C-3
C863	Same as C862	
C864	Same as C862	
C865	Same as C862	
C866	Same as C862	
C867	Same as C862	
C868	Same as C862	
C869	Same as C862	
C870	Same as C717	
C871	Same as C717	
C872	Same as C717	
C873	Same as C717	
C874	Same as C717	
C875	Same as C717	
C876	Same as C717	
C877	Same as C717	
C878	Same as C717	
C879	CFC, 1000pf, GMV, 1000 VDCW	C-19
C880	CFD, 2000pf, 1000 VDCW	C-133
C881	CFC, .1µf, 600 VDCW	C-69
CR701	DS, 1N2094	D-7
CR702	DS, 1N34A	D-2
CR703	Same as CR702	
CR704	Same as CR702	
CR705	Same as CR702	
CR706	Same as CR701	
CR707	Same as CR701	
CR708	DS, 1N734A	D-14
CR709	Same as CR708	

CIRCUIT REFERENCE NO.	DESCRIPTION	TELONIC PART NO.
CR851	DS, 1N34AS	D-9
CR852	Same as CR851	
CR853	Same as CR851	
CR854	Same as CR851	
CR855	Same as CR851	
CR856	Same as CR851	
CR857	Same as CR851	
CR858	Same as CR851	
CR859	Same as CR851	
CR860	Same as CR851	
CR861	Same as CR851	
CR862	Same as CR851	
CR863	Same as CR851	
CR864	Same as CR851	
CR865	Same as CR851	
CR866	Same as CR851	
CR867	Same as CR851	
CR868	Same as CR851	
CR869	Same as CR851	
CR870	Same as CR851	
CR871	Same as CR851	
CR872	Same as CR851	
CR873	Same as CR851	
CR874	Same as CR851	
CR875	Same as CR851	
CR876	Same as CR851	
CR877	Same as CR851	
CR878	Same as CR701	
CR879	Same as CR701	
CR880	Same as CR701	
J701	TC, MX-1684A/U	J-54
J702	Post, binding, red	MP-12
J703	Post, binding, black	MP-11
J851	RJ	J-10
P601	Plug, 32-contact	S-39
P701	PC, UG-88C/U	J-13
L701	Reactor, saturable	L-203
L702	IV, 6-11mh	L-40
L703	IF, 1mh	L-116
L704	Same as L703	
L801	IV, 440-800μh	L-35
L802	Same as L801	
L803	Same as L801	
L804	Same as L801	

CIRCUIT REFERENCE NO.	DESCRIPTION	TELONIC PART NO.
L805	IV, 238-450µh	L-36
L806	Same as L805	
L807	Same as L805	
L808	Same as L805	
L809	IV, 120-243µh	L-37
L810	Same as L809	
L811	IV, 29-63µh	L-38
L812	Same as L811	
L851	Same as L811	
L852	IV, 16-28µh	L-39
L853	Same as L811	
R601	RFC, 5.6MΩ, ±10%, 1/2W	R-50
R602	Not assigned	
R603	RVC, 1KΩ, 2W	R-757
R604	RVC, 250KΩ, 2W	R-752
R605	RFC, 100KΩ, ±5%, 1/2W	R-111
R606	RVC, 25KΩ, 0.2W	R-742
R607	RFC, 39KΩ, ±5%, 1/2W	R-112
R608	RVC, 100KΩ, 2W	R-758
R609	Same as R606	
R610	RFC, 220KΩ, ±10%, 1/2W	R-44
R611	RFC, 100KΩ, ±10%, 1/2W	R-28
R612	RFC, 390Ω, ±10%, 1/2W	R-58
R701	Same as R610	
R702	RFC, 39KΩ, ±10%, 1/2W	R-26
R703	RFC, 10KΩ, ±10%, 1/2W	R-23
R704	Same as R611	
R705	Same as R611	
R706	RFC, 560KΩ, ±10%, 1/2W	R-29
R707	RFC, 18KΩ, ±10%, 1/2W	R-46
R708	RVC, 500KΩ, 0.2W	R-712
R709	Not assigned	
R710	RFC, 220Ω, ±5%, 1/2W	R-7
R711	RFC, 47KΩ, ±10%, 1/2W	R-27
R712	RFC, 68KΩ, ±10%, 1/2W	R-51
R713	RFC, 180KΩ, ±10%, 1/2W	R-45
R714	Same as R611	
R715	Same as R706	
R716	RFC, 22KΩ, ±10%, 1/2W	R-24
R717	RFC, 470KΩ, ±10%, 1/2W	R-73
R718	RFC, 56KΩ, ±10%, 1/2W	R-71
R719	RFC, 100Ω, ±10%, 1/2W	R-15
R720	RVC, 1KΩ, 0.3W	R-710
R721	RFC, 1.8KΩ, ±10%, 1/2W	R-19
R722	Same as R721	
R723	RFC, 3.3KΩ, ±10%, 1/2W	R-70

CIRCUIT REFERENCE NO.	DESCRIPTION	TELONIC PART NO.
R724	Same as R723	
R725	RFC, 270KΩ, ±10%, 1/2W	R-62
R726	Same as R725	
R727	RVC, 100KΩ, 0.2W	R-711
R728	Not assigned	
R729	Same as R716	
R730	Same as R611	
R731	RVC, 200KΩ, 0.2W	R-755
R732	Same as R611	
R733	Same as R716	
R734	RFW, 200Ω, 5W	R-400
R735	RFC, 22Ω, ±10%, 2W	R-309
R736	RFW, 1KΩ, 10W	R-512
R737	RFC, 2.2KΩ, ±10%, 1W	R-222
R738	RFC, 120Ω, ±5%, 2W	R-326
R739	Same as R738	
R740	Same as R738	
R741	RFC, 680Ω, ±10%, 1/2W	R-59
R742	Same as R713	
R743	Same as R713	
R744	Same as R610	
R745	Same as R610	
R801	Same as R611	
R802	Same as R611	
R803	Same as R707	
R804	Same as R719	
R805	RFC, 15KΩ, ±10%, 1/2W	R-66
R806	Same as R805	
R807	Same as R707	
R808	Same as R719	
R809	Same as R805	
R810	Same as R805	
R811	Same as R707	
R812	Same as R719	
R813	Same as R805	
R814	Same as R805	
R815	Same as R719	
R816	Same as R805	
R817	Same as R805	
R818	Same as R719	
R819	Same as R805	
R820	Same as R805	
R821	Same as R719	
R822	Same as R719	
R823	Same as R719	
R824	Same as R719	
R825	Same as R719	
R826	Same as R719	

CIRCUIT REFERENCE NO.	DESCRIPTION	TELONIC PART NO.
R851	Same as R712	
R852	Same as R703	
R853	Same as R712	
R854	Same as R703	
R855	Same as R611	
R856	Same as R805	
R857	Same as R805	
R858	Same as R805	
R859	Same as R805	
R860	Same as R805	
R861	Same as R805	
R862	Same as R805	
R863	Same as R805	
R864	Same as R708	
R865	Same as R708	
R866	Same as R708	
R867	Same as R708	
R868	Same as R708	
R869	Same as R708	
R870	Same as R708	
R871	Same as R708	
R872	Same as R708	
R873	Same as R611	
R874	Same as R611	
R875	Same as R611	
R876	Same as R611	
R877	Same as R611	
R878	Same as R611	
R879	Same as R611	
R880	Same as R611	
R881	Not assigned	
R882	Same as R703	
R883	Part of R888	
R884	RFC, 8.2KΩ, ±10%, 1/2W	R-43
R885	RFC, 22MΩ, ±10%, 1/2W	R-48
R886	Same as R601	
R887	Same as R727	
R888	RVC, dual, 1MΩ, 1/4W/25KΩ, 1/3W	R-759
R889	RFC, 390KΩ, ±10%, 1/2W	R-72
R890	Same as R717	
R891	RFC, 1KΩ, ±10%, 1/2W	R-18
R892	RFC, 100KΩ, ±10%, 1/2W	R-28
S701	SWT, 3PDT	SW-30
S851	SWT, SPST	SW-10
S852	Same as S851	
S853	Same as S851	
S854	Same as S851	
S855	Same as S851	

CIRCUIT REFERENCE NO.	DESCRIPTION	TELONIC PART NO.
S856	Same as S851	
S857	Same as S851	
S858	Same as S851	
S859	SWT, SPDT	SW-31
T701	Transformer, Pulse	T-16
T702	Same as T701	
T703	Transformer, Audio	T-17
V701	TE, 6U8	VT-8
V702	Same as V701	
V703	TE, 6ES8	VT-52
V704	TE, 12AX7	VT-13
V705	Same as V704	
V706	TE, EL84/6BQ5	VT-16
V707	Same as V706	
V801	TE, 12AT7	VT-10
V802	Same as V801	
V803	Same as V801	
V804	TE, 12AV7	VT-12
V805	Same as V804	
V806	Same as V804	
V851	TE, 6GH8A	VT-46
V852	Same as V704	
Y701	QC, 100Kc	X-5-0.1Mc
Y851	QC, 2Mc	X-1-2.0Mc
Y852	QC	X-6-*
Y853	Same as Y852	
Y854	Same as Y852	
Y855	Same as Y852	
Y856	Same as Y852	
Y857	Same as Y852	
Y858	Same as Y852	
Y859	Same as Y852	

* Frequency desired. See Crystal Frequency List

RJ, UG-625/U	J-7
Terminal Strip, 8-terminal	MP-17
Terminal Board, 8 terminals	MP-145
Socket, tube, 9-pin (11 required)	S-58
Socket, tube, 9-pin (4 required)	S-37
Clip, diode (4 required)	S-9
Shield, tube (11 required)	S-60
Socket, Crystal	S-18

ABBREVIATION CODE

CFC	Capacitor, fixed, ceramic
CFD	Capacitor, fixed, discap.
CFE	Capacitor, fixed, electrolytic
CFM	Capacitor, fixed, mica
CFP	Capacitor, fixed, paper
CFMY	Capacitor, fixed, Mylar
CVA	Capacitor, variable, air
DS	Device, semiconductor
IF	Inductor, fixed
IV	Inductor, variable
PC	Plug, cable
QC	Quartz, Crystal
RFC	Resistor, fixed, composition
RFW	Resistor, fixed, wirewound
RJ	Receptacle, jack
RVC	Resistor, variable, composition
SC	Subject to change
SWT	Switch, toggle
TC	Terminator, cable
TE	Tube, electron

CRYSTAL FREQUENCIES

AUDIO FREQ. (CPS)	SWP. OSC. FREQ. (KC)	CRYSTAL FREQ. (MC)
0	100.0	6.4000
100	100.1	6.4064
200	100.2	6.4128
300	100.3	6.4192
400	100.4	6.4256
500	100.5	6.4320
600	100.6	6.4384
700	100.7	6.4448
800	100.8	6.4512
900	100.9	6.4576
1000	101.0	6.4640
1100	101.1	6.4704
1200	101.2	6.4768
1300	101.3	6.4832
1400	101.4	6.4896
1500	101.5	6.4960
1600	101.6	6.5024
1700	101.7	6.5088
1800	101.8	6.5152
1900	101.9	6.5216
2000	102.0	6.5280
2100	102.1	6.5344
2200	102.2	6.5408
2300	102.3	6.5472
2400	102.4	6.5536
2500	102.5	6.5600
2600	102.6	6.5664
2700	102.7	6.5728
2800	102.8	6.5792
2900	102.9	6.5856
3000	103.0	6.5920
3100	103.1	6.5984
3200	103.2	6.6048
3300	103.3	6.6112
3400	103.4	6.6176
3500	103.5	6.6240
3600	103.6	6.6304
3700	103.7	6.6368
3800	103.8	6.6432
3900	103.9	6.6496
4000	104.0	6.6560
4100	104.1	6.6624
4200	104.2	6.6688
4300	104.3	6.6752
4400	104.4	6.6816
4500	104.5	6.6880
4600	104.6	6.6944
4700	104.7	6.7008
4800	104.8	6.7072
4900	104.9	6.7136
5000	105.0	6.7200
5100	105.1	6.7264
5200	105.2	6.7328
5300	105.3	6.7392
5400	105.4	6.7456
5500	105.5	6.7520
5600	105.6	6.7584
5700	105.7	6.7648
5800	105.8	6.7712
5900	105.9	6.7776
6000	106.0	6.7840
6100	106.1	6.7904
6200	106.2	6.7968
6300	106.3	6.8032
6400	106.4	6.8096
6500	106.5	6.8160
6600	106.6	6.8224
6700	106.7	6.8288
6800	106.8	6.8352
6900	106.9	6.8416
7000	107.0	6.8480
7100	107.1	6.8544
7200	107.2	6.8608
7300	107.3	6.8672
7400	107.4	6.8736
7500	107.5	6.8800
7600	107.6	6.8864
7700	107.7	6.8928
7800	107.8	6.8992
7900	107.9	6.9056
8000	108.0	6.9120
8100	108.1	6.9184
8200	108.2	6.9248
8300	108.3	6.9312
8400	108.4	6.9376
8500	108.5	6.9440
8600	108.6	6.9504
8700	108.7	6.9568
8800	108.8	6.9632
8900	108.9	6.9696
9000	109.0	6.9760

AUDIO FREQ. (KC)	SWP. OSC. FREQ. (KC)	CRYSTAL FREQ. (MC)
9.1	109.1	6.9824
9.2	109.2	6.9888
9.3	109.3	6.9952
9.4	109.4	7.0016
9.5	109.5	7.0080
9.6	109.6	7.0144
9.7	109.7	7.0208
9.8	109.8	7.0272
9.9	109.9	7.0336
10.0	110.0	7.0400
10.1	110.1	7.0464
10.2	110.2	7.0528
10.3	110.3	7.0592
10.4	110.4	7.0656
10.5	110.5	7.0720
10.6	110.6	7.0784
10.7	110.7	7.0848
10.8	110.8	7.0912
10.9	110.9	7.0976
11.0	111.0	7.1040
11.1	111.1	7.1104
11.2	111.2	7.1168
11.3	111.3	7.1232
11.4	111.4	7.1296
11.5	111.5	7.1360
11.6	111.6	7.1424
11.7	111.7	7.1488
11.8	111.8	7.1552
11.9	111.9	7.1616
12.0	112.0	7.1680
12.1	112.1	7.1744
12.2	112.2	7.1808
12.3	112.3	7.1872
12.4	112.4	7.1936
12.5	112.5	7.2000
12.6	112.6	7.2064
12.7	112.7	7.2128
12.8	112.8	7.2192
12.9	112.9	7.2256
13.0	113.0	7.2320
13.1	113.1	7.2384
13.2	113.2	7.2448
13.3	113.3	7.2512
13.4	113.4	7.2576
13.5	113.5	7.2640
13.6	113.6	7.2704
13.7	113.7	7.2768
13.8	113.8	7.2832
13.9	113.9	7.2896
14.0	114.0	7.2960
14.1	114.1	7.3024
14.2	114.2	7.3088
14.3	114.3	7.3152
14.4	114.4	7.3216
14.5	114.5	7.3280
14.6	114.6	7.3344
14.7	114.7	7.3408
14.8	114.8	7.3472
14.9	114.9	7.3536
15.0	115.0	7.3600
15.1	115.1	7.3664
15.2	115.2	7.3728
15.3	115.3	7.3792
15.4	115.4	7.3856
15.5	115.5	7.3920
15.6	115.6	7.3984
15.7	115.7	7.4048
15.8	115.8	7.4112
15.9	115.9	7.4176
16.0	116.0	7.4240
16.1	116.1	7.4304
16.2	116.2	7.4368
16.3	116.3	7.4432
16.4	116.4	7.4496
16.5	116.5	7.4560
16.6	116.6	7.4624
16.7	116.7	7.4688
16.8	116.8	7.4752
16.9	116.9	7.4816
17.0	117.0	7.4880
17.1	117.1	7.4944
17.2	117.2	7.5008
17.3	117.3	7.5072
17.4	117.4	7.5136
17.5	117.5	7.5200
17.6	117.6	7.5264
17.7	117.7	7.5328
17.8	117.8	7.5392
17.9	117.9	7.5456
18.0	118.0	7.5520
18.1	118.1	7.5584
18.2	118.2	7.5648
18.3	118.3	7.5712
18.4	118.4	7.5776
18.5	118.5	7.5840
18.6	118.6	7.5904
18.7	118.7	7.5968
18.8	118.8	7.6032
18.9	118.9	7.6096
19.0	119.0	7.6160
19.1	119.1	7.6224
19.2	119.2	7.6288
19.3	119.3	7.6352
19.4	119.4	7.6416
19.5	119.5	7.6480
19.6	119.6	7.6544
19.7	119.7	7.6608
19.8	119.8	7.6672
19.9	119.9	7.6736
20.0	120.0	7.6800

SECTION VII

SCHEMATIC DIAGRAMS

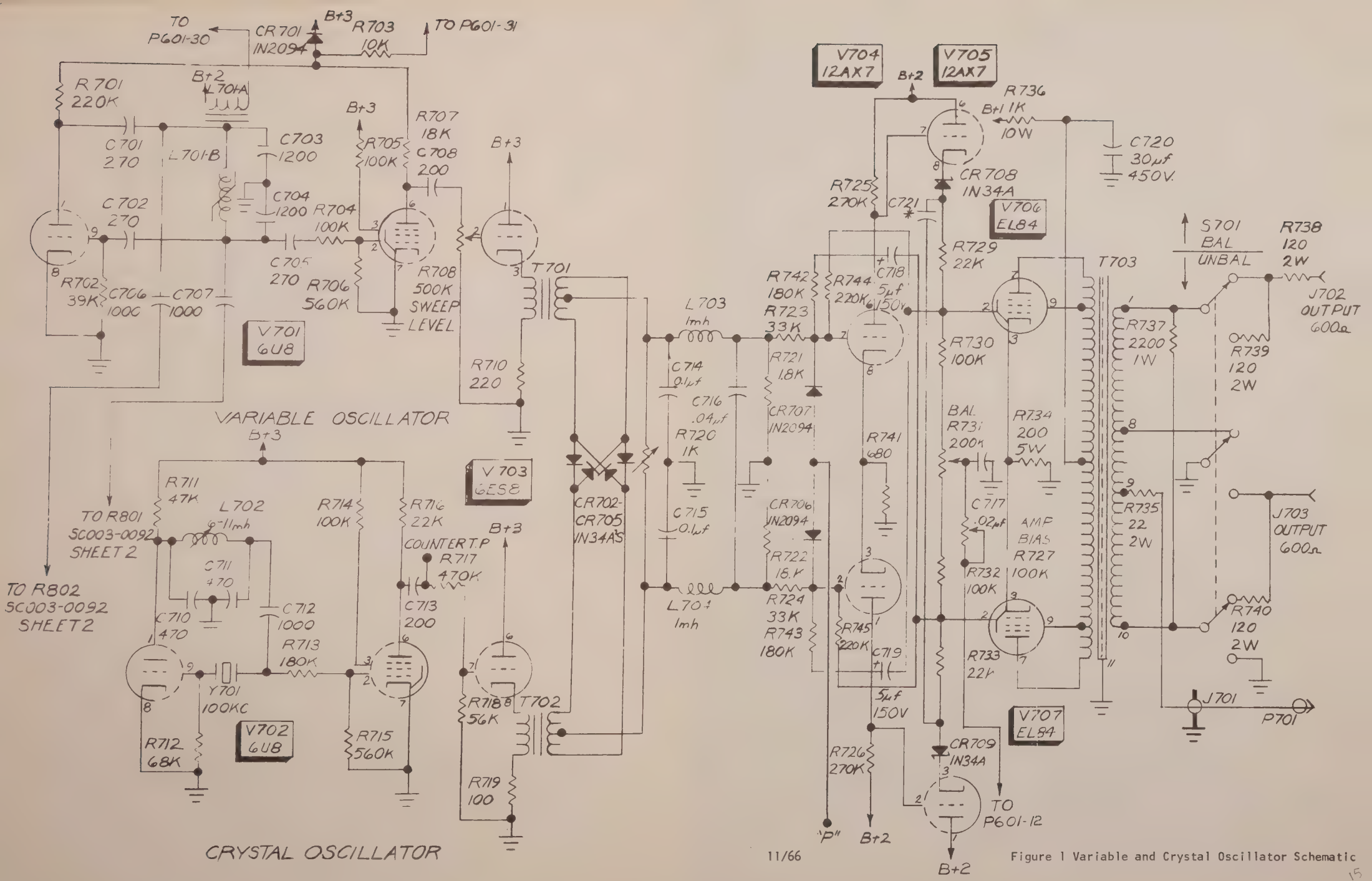


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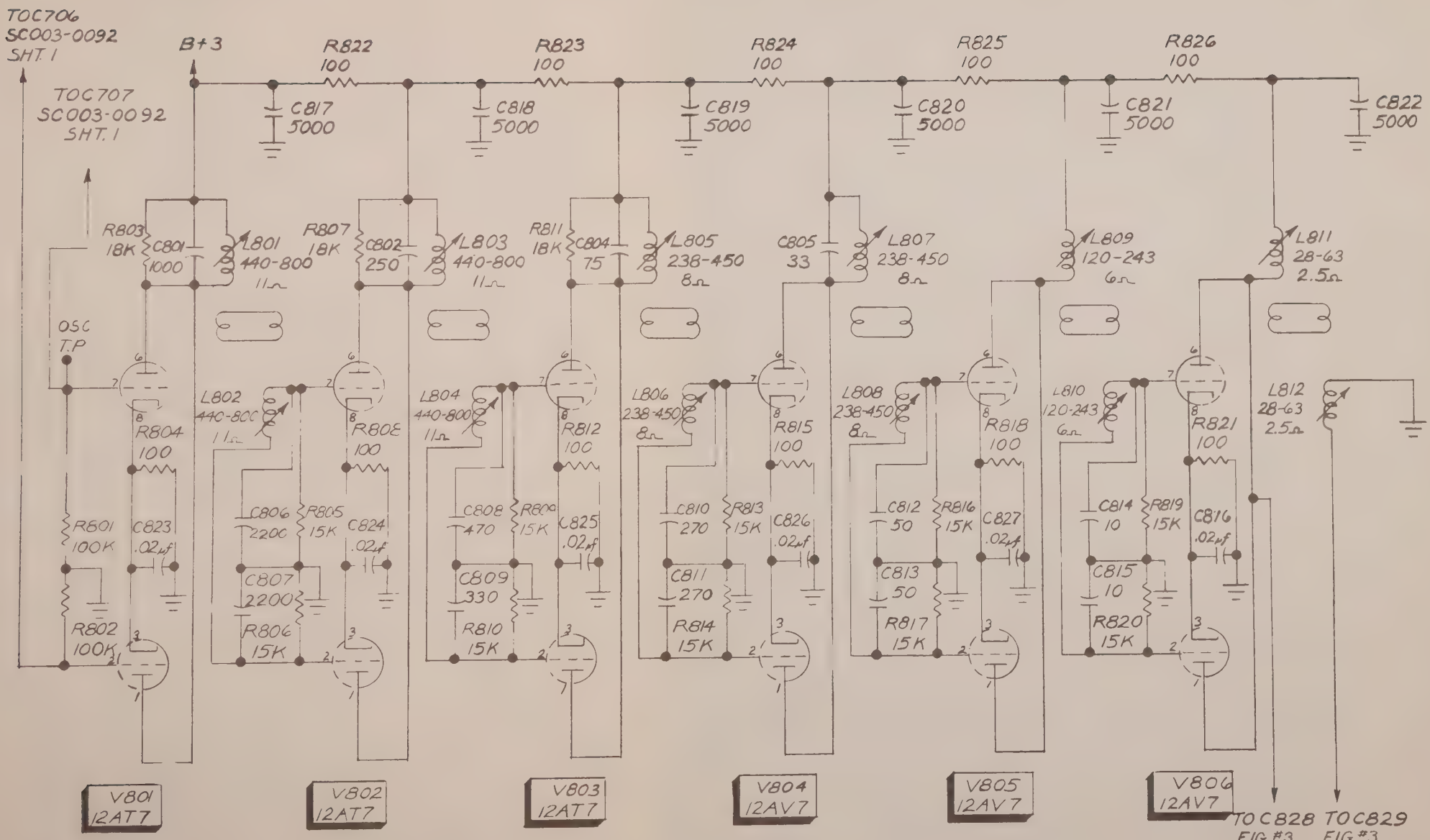
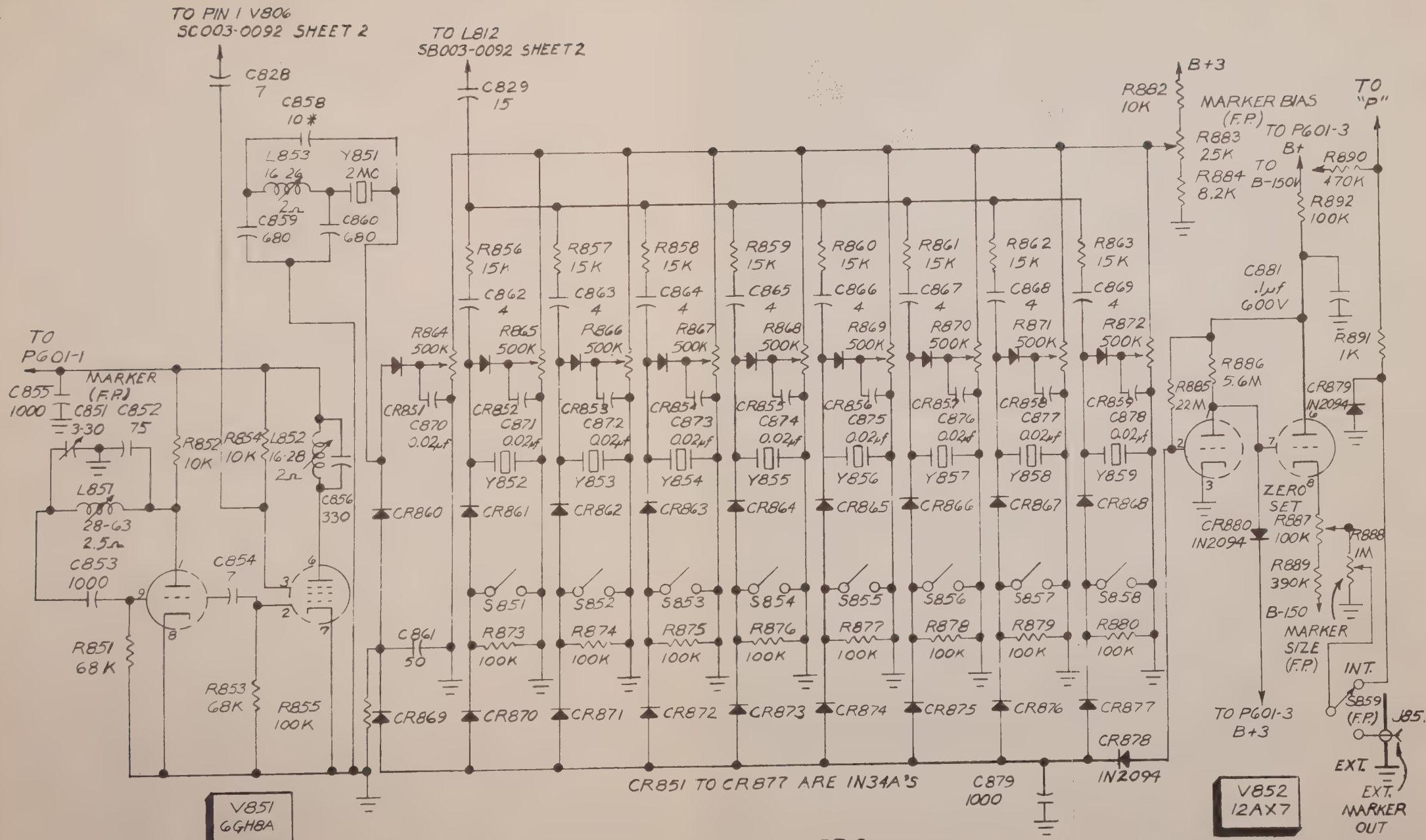
Figure 1 Variable and Crystal Oscillator Schematic



SWEEP MULTIPLIER CHAIN

Figure 2 Sweep Multiplier Chain Schematic



MARKERS

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Figure 3 Markers Schematic

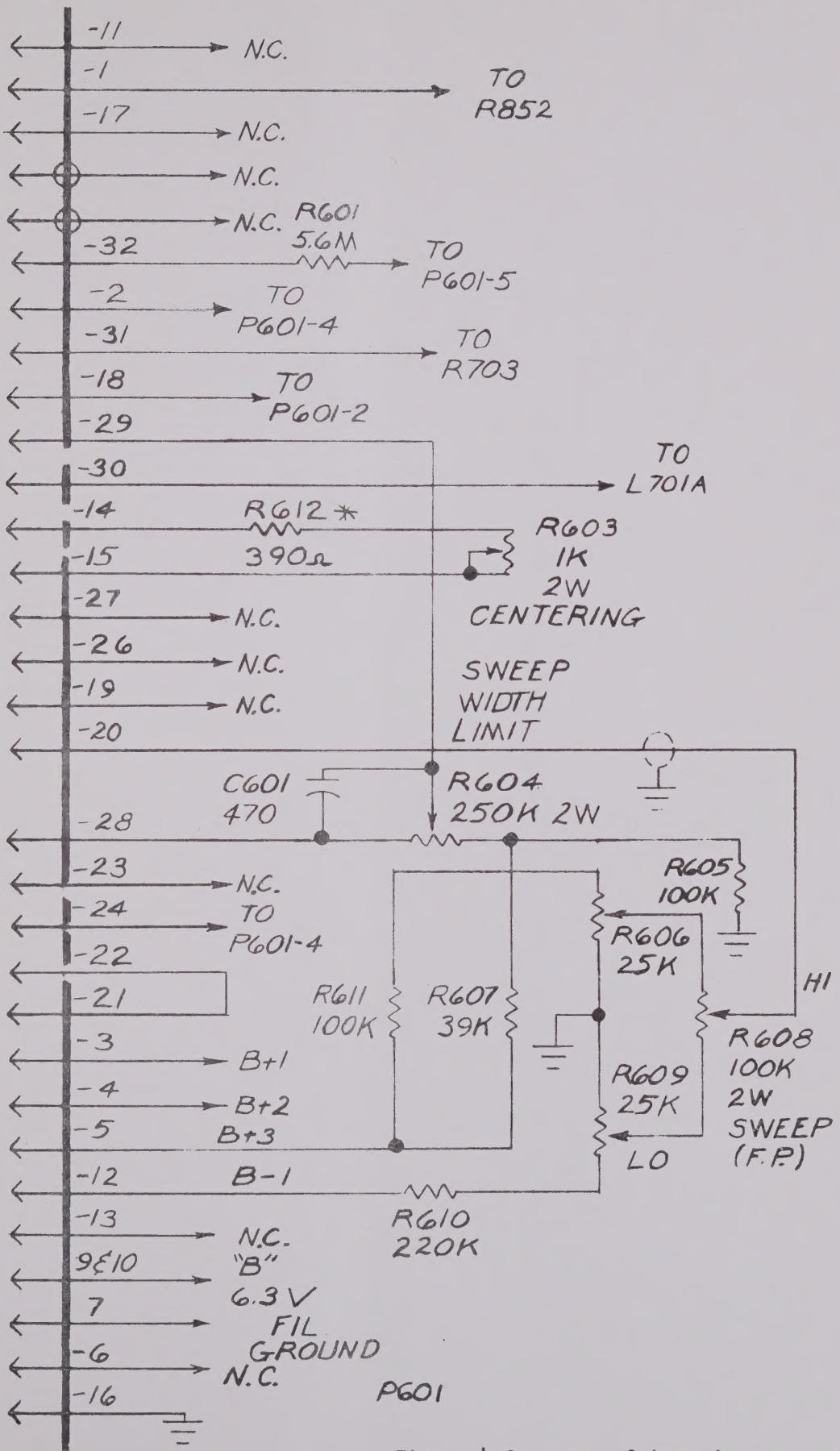

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Figure 4 Connector Schematic